



Doctoral Thesis

Pullus Impexus(Muls.)(Coleoptera, Coccinellidae) a predator of Adelges Piceae (Ratz.) (Hemiptera, Adelgidae), with notes on its parasites (European investigations)

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Publication Date:

1954

Permanent Link:

<https://doi.org/10.3929/ethz-a-000133877> →

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PULLUS IMPEXUS (MULS.)

(COLEOPTERA, COCCINELLIDAE)

A PREDATOR OF

ADELGES PICEAE (RATZ.)

(HEMIPTERA, ADELGIDAE),

WITH NOTES ON ITS PARASITES.

(European Investigations)

Thesis presented to
THE SWISS FEDERAL INSTITUTE OF TECHNOLOGY, ZURICH
for the degree of
DOCTOR OF TECHNICAL SCIENCES

by

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of Arogno (Tessin).

Accepted on the recommendation of
Prof. Dr. P. Bovey and Prof. Dr. J. Seiler.

LONDON:
Commonwealth Institute of Entomology,
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1954

RÉSUMÉ

Le présent travail a été entrepris dans le cadre des recherches effectuées en Suisse, en Allemagne et en France par le Laboratoire européen du "Commonwealth Institute of Biological Control" sur les prédateurs de *Adelges piceae* (Ratz.). Il se rapporte à l'un des éléments les plus intéressants de cette biocénose complexe, le Coccinellide *Pullus impevus* (Muls.) dont la biologie était à peu près inconnue.

Nous avons clarifié la position systématique de la larve et de l'adulte et rassemblé toutes les informations possibles sur la distribution de cette espèce.

Les résultats de nos recherches biologiques peuvent se résumer comme suit:

1. *Pullus impevus* n'a qu'une génération par an.
2. Les oeufs sont pondus durant la seconde moitié de l'été sur les *Abies alba* infestés. Ils hivernent pour éclore au mois d'avril suivant.
3. Le développement larvaire s'accomplit en avril-mai et les adultes apparaissent en juin.
4. Durant le mois de juin, on trouve simultanément sur les arbres les adultes de la nouvelle et de la précédente générations.
5. Nous avons précisé les conditions de nutrition des larves et adultes de *P. impevus* de manière à établir leur valeur comme agents de lutte biologique.
6. Deux nouvelles espèces d'hyménoptères parasites, obtenues dans nos élevages font l'objet d'une description et d'une étude détaillées. *Scymnophagus mesnili* Ferr. vit dans les nymphes tandis que *Centistes scymni* Ferr. s'attaque aux adultes. Ces deux parasites constituent un facteur très important dans la diminution de la population du prédateur. D'autres prédateurs de *Adelges piceae* tels *Syrphus arcuatus* Fall., *Chrysopa ventralis* Curt. et *Cnemodon latitarsis* Egg. peuvent aussi attaquer les stades préimaginaux de *P. impevus*.
7. Nous avons mentionné l'existence d'une grégarine dans le mésenteron des adultes de *P. impevus* et d'un nématode dans l'abdomen d'une femelle.
8. Tous les détails nécessaires sur la technique d'élevage en masse et l'expédition au Canada ont été fournis comme conclusion de notre travail.

consisting of two small crossed boards fixed to the corner reinforcers. A square of organdie is glued to them. The space between the organdie and the box bottom is filled with moist sterilised sphagnum to maintain a constant relative humidity above 90 per cent. The organdie prevents the smallest insects from entering the sphagnum.

For the shipment of insects the inside of the box was provided, in 1951, with a wet sponge, wrapped in filter paper and fixed vertically at one corner of the box. This sponge was not included in the boxes in 1952. For food, the solution of Parker (1948) in drops on cardboard was placed on the inside of the box.

Before any insects were shipped to Canada, laboratory experiments were undertaken to determine their behaviour and survival in all stages and under varying conditions within the shipping boxes. Each insect species reacted differently and the mortality varied even for different stages of the same species. For the most part, the investigations were carried out at a temperature of 15°C. The relative humidity was varied, using sphagnum moss with different moisture contents and the insects were also tested both with and without the presence of artificial food.

Summary.

The biology of *Pullus impexus* (Muls.), a Coccinellid beetle predacious on *Adelges piceae* (Ratz.) in Switzerland, Germany and France, was studied during 1950–1952. The present work is a part of the research on the complex problem of factors in the control of the Balsam Woolly Aphid in Canada.

The morphology of both the larva and the adult has been studied. Some information has been provided on the probable distribution of the species.

P. impexus has only one generation a year. The eggs are deposited during the late summer or early autumn on infested trees and the larvae hatch in April. The larvae develop and adults appear in May. The adults of the new generation are to be found in June together with adults of the old generation. In the biology, particular attention has been directed to the diet of the insect in each of its stages, in order to establish the value of the species from the standpoint of biological control.

Two new species of Hymenopterous parasites were found in Switzerland and in Germany, *Scymnophagus mesnili* Ferr., a parasite of pupae, and *Centistes scymni* Ferr., a parasite of the imagines. The life history of these species has been briefly studied. A cephaline gregarine species was noted in the mesenteron of adults of *P. impexus* and a nematode in the abdominal cavity of a female. The two Hymenopterous species provide an important limiting factor in the increase of the population of *P. impexus*.

Chrysopa ventralis Curt., *Syrphus arcuatus* (Fall.) and *Cnemodon latitarsis* Egg. are mentioned, acting as predators of *P. impexus* larvae and pupae.

The organisation of the mass-rearing of *P. impexus* in Europe as well as the shipping of the insects to Canada in special wooden boxes completes the study.

Acknowledgements.

The present study was undertaken at the European Laboratory of the Commonwealth Institute of Biological Control, Feldmeilen, Switzerland. I wish to express my deepest gratitude for the expert guidance and teaching provided during the past three years by Prof. L. P. Mesnil, in charge of the Laboratory. I am especially indebted to Prof. Dr. P. Bovey, of the Institute of Entomology of the Swiss Federal Institute for Technology, Zurich, who has been good enough to accept the present study as a doctoral thesis and has shown consistent interest and given valuable advice during the course of the investigations.

Further thanks are also extended to the following: Dr. W. R. Thompson,